EARL,
please take a look @ this & let's discuss
- I sent Elmer a CC mail regarding
your assistance. Thanks,
ART

Prepared for:

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PROPOSAL FOR AN ENVIRONMENTAL ASSESSMENT OF LUCAS CREEK, NUCOR STEEL FACILITY DARLINGTON, SOUTH CAROLINA

October 1995

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1.0 INTRODUCTION

ChemRisk®, the human health and ecological risk assessment division of McLaren/Hart Environmental Engineering Corporation, is pleased to respond to NUCOR Steel's request for a proposal (RFP) to design and implement an environmental assessment of Lucas Creek for NUCOR Steel's Darlington, South Carolina facility. As proposed, this evaluation will involve a phased, integrated assessment, designed, in a cost-effective manner, to evaluate the potential for adverse environmental effects from exposure to surface water and sediments in Lucas Creek and the surrounding environs.

By way of background and introduction, the ChemRisk Division of McLaren/Hart Environmental Engineering Corporation is one of the nation's premier risk assessment groups specializing in the evaluation of environmental and human health exposures and the characterization of risk. ChemRisk has one of the largest technical staffs in the country dedicated solely to the practice of solving environmental problems using the methods and techniques of risk assessment and applied toxicology and the ecological sciences. The ChemRisk team of nearly 100 health and environmental professionals, many of whom hold Ph.D. and Master's degrees, spans a full range of disciplines including human and ecological toxicologists, aquatic and terrestrial biologists, environmental chemists, regulatory specialists, computer programmers, statisticians, and chemical fate and transport modeling experts. Our Warren, New Jersey and Portland, Maine offices are particularly experienced in evaluating metals, and chlorinated organic compounds such as chlorinated dioxins, furans, pesticides, and PCBs; in conducting contaminated surface water and sediment investigations; and in evaluating impacts to wetland and aquatic ecosystems.

ChemRisk has one of the most experienced field teams for developing and implementing cost-effective field sampling programs. Our staff ecologists have over 20 years experience in designing field programs that range from preliminary ecological assessments to comprehensive evaluations in support of Remedial Investigations and Feasibility Studies (RI/FS). ChemRisk has the capability to develop and implement multi-trophic level biological, and toxicological sampling plans designed to identify potential environmental impacts and ecological risk. Our

sampling programs have included the collection, analysis, and evaluation of toxicological effects of contaminated sediments on freshwater and marine biota. All of our sampling programs have been designed to meet specific client needs by providing a cost-effective, yet thorough approach. Models simulating chemical fate and transport, food web transfers, Monte Carlo analysis, bioenergetics, and chemical source fingerprinting are just some of the specialized tools commonly applied in our assessments. A simple food web model will be utilized in support of the NUCOR project.

The following example projects illustrate our experience at developing and implementing aquatic investigations.

- ChemRisk is presently involved in negotiations with EPA Region IV at a CERCLA Site in North Carolina. The present scope of activity has included the review of an agency sponsored risk assessment and the development of a risk-based remediation strategy for the Site. The resulting comments were included in the public record for the Site.

- ChemRisk conducted a wetlands evaluation and assessment for a financial institution in Hilton Head, South Carolina. The project entailed delineation of the wetlands, and evaluation of their functional capabilities and interaction with the South Carolina DEHC and the U.S. Corps of Engineers in gaining approval of the delineation boundaries.

- ChemRisk has recently been retained to address environmental concerns at three CERCLA locations in North Carolina. The project activities to data have included preliminary discussions with EPA Region IV concerning project scope and direction.

- McLaren/Hart is supporting the Department of Energy at the Savannah River Site in South Carolina. The project has included the demonstration of expedited sampling procedures at an oil disposal facility. The project required extensive negotiations with DHEC over sampling procedures, risk approaches and laboratory deliverables.

- McLaren/Hart is presently providing consulting services to a confidential client that involves the implementation of a RCRA Post-Closure Care Monitoring Program at a Site in EPA Region IV. Routine tasks include development of an overall site management program, periodic groundwater sampling, soil sampling, surface water sampling, and stormwater sampling and maintenance of required documents in files on-site. In addition, McLaren/Hart has recently prepared modifications to the facility's RCRA Permit in an attempt to reduce the amount of RCRA Post-Closure care activities at the Site. These permit modifications will ultimately result in a substantial cost savings to our client. McLaren/Hart is drawing upon numerous years of experience in regulatory negotiation to support our client's position in obtaining approval of the modifications.

- ChemRisk has participated in negotiations with EPA, NOAA, and other public agencies to evaluate the nature and extent of the sediment contamination and various remediation options in the Passaic River, Newark, New Jersey. ChemRisk's evaluations of the Passaic River sediments and related ecological investigations are an example of one of the largest projects of its kind in the United States, encompassing the Newark Bay, New Jersey estuary and its major tributaries. The sediment sampling program conducted by the ChemRisk project team is among the most comprehensive sediment investigations conducted in an urban estuary. From 1990 to present, field investigations involved the collection of more than one hundred sediment cores and analysis of nearly three hundred sediment samples for PAHs, VOCs, metals, PCBs, organochlorines, PCDD/Fs, ^{137}Cesium, ^{210}Lead, and pesticides. Chemical and radioisotope results have been used to determine sedimentation conditions and establish pollution histories of key chemicals throughout the estuary. Numerous potential point and nonpoint sources of contamination have been investigated using chemometric pattern recognition techniques to identify PCDD, PCDF, metal, and PCB fingerprint patterns in buried and surface sediments. To date, the ChemRisk project team has submitted or published more than twenty papers in the peer-review literature on the sources and distribution of chemicals in sediments and their potential toxicity to aquatic organisms as a result of the Passaic River work.

- At the Packaging Corporation of America (PCA) Superfund Site in Manistee, Michigan, ChemRisk developed site-specific, risk-based cleanup criteria. The EPA had placed this site on the National Priorities List (NPL) because heavy metals (primarily arsenic and chromium) were detected in a groundwater plume emanating from several former lagoons and were discharging into Manistee Lake. Potential impacts of this plume on Manistee Lake were evaluated and addressed in our baseline health and ecological risk assessment. Consistent with Michigan Act 307 Type C methodology and EPA policy, we developed alternative risk-based cleanup levels for groundwater as part of the feasibility study submitted to EPA Region V and the state. The EPA accepted the evaluations performed by ChemRisk and issued a Record of Decision calling for site monitoring and access restriction, rather than a pump-and-treat remedial option. Furthermore, EPA accepted our ecological analysis which showed no significant impacts on aquatic life despite exceedances of Michigan water quality criteria.

- ChemRisk has represented several industrial clients by providing comments to the EPA on the limitations in draft sediment quality criteria for specific chemicals and in the general methodology currently being used to develop these criteria. ChemRisk has also undertaken studies to evaluate the concordance between sediment quality criteria and effects-based criteria for sediments contaminated with a variety of chemicals. The results of these studies have been useful in developing a variety of innovative, scientific approaches to effectively serve our clients that have sites with contaminated sediment issues.

- PPG Industries has retained ChemRisk to conduct a risk-based RCRA Facility Investigation (RFI) of their chemical manufacturing site in Lake Charles, Louisiana. Located on the Calcasieu River, 35 miles from the Gulf of Mexico, this plant has manufactured caustics, chlorine, vinyl chloride, and ethylene chloride since the late 1940s. The manufacture of these products may be associated with the possible environmental releases of chlorinated benzene, hexachlorobutadiene, and mercury. Recently, the State of Louisiana and EPA Region VI became concerned about the

- potential ecological and human health hazards associated with these contaminants in the river, its estuary, and in the Chicot Aquifer community water supply. ChemRisk has developed a risk-based approach to evaluate these concerns and to select appropriate site restoration activities. This risk-based RCRA corrective action project will take place over the next 4 years and is regarded by EPA and the state as a test case for evaluating the efficacy of risk-based solutions to issues concerning environmental contamination.

- ChemRisk was also retained by PPG Industries to incorporate risk assessment principles into ongoing RFI activities at the Barberton, OH facility for the purpose of achieving a risk-based, yet cost-effective solution. ChemRisk is currently involved in several site-related projects that combine risk-based strategies with advanced site investigatory activities including: (1) fish sampling from adjacent waterbodies for tissue analysis, (2) interpretation of RFI data for measured concentrations of dioxins in surface waters and sediment in waterbodies and at on-site locations, (3) defining additional sampling programs for further characterization of elevated concentrations of dioxins, and (4) development of a risk assessment scoping document that describes the comprehensive scope of work and strategy for risk assessment activities at the facility.

- ChemRisk conducted an ecological risk assessment on behalf of a multi-PRP committee for a Superfund site in San Francisco Bay, California where organochlorine pesticides were the chemicals of concern. Our evaluation indicated that only sediments in the most contaminated area pose a possible threat to aquatic organisms. Negotiations are presently focused on remediating only 50,000 cubic yards of the most contaminated sediment rather than the 600,000 cubic yards that had been originally identified.

- As part of an ecological risk assessment designed to evaluate the health of terrestrial wildlife populations and communities potentially exposed to PCBs in soils of the Housatonic River floodplain in Massachusetts, ChemRisk designed and conducted a community-level "top-down" evaluation. The purpose of the study was to ascertain whether diversity, density, and reproductive success of key wildlife species (birds and

small mammals) living in contaminated areas, were within normal ranges as reported in the literature, and whether they compared favorably to populations inhabiting uncontaminated reference areas. By monitoring the actual ecosystem potentially at risk, this approach allowed determination of whether wildlife are healthy and whether the ecological system on which they depend is healthy and functional. The overall weight of evidence indicated that the terrestrial flood plain ecosystem supports a balanced and healthy wildlife community that is not impacted by the presence of PCBs. This study was submitted to the state and federal regulators who concluded that, "in general, this evaluation is well done and provides a valuable body of information about the terrestrial ecosystem."

- In further support of ongoing ecological investigations of the Housatonic River, ChemRisk conducted a population-level analysis of potential effects of PCBs on great blue herons. In this analysis, ChemRisk calculated a population-level toxicity quotient and validated those findings through field studies. The toxicity quotient addressed the critical effect of reproductive impairment, based on estimated exposure to PCBs through fish consumption. The locations and sizes of existing colonies within the Housatonic River valley were evaluated in order to arrive at rates of ingestion by Housatonic River fish on a colony-specific basis. Actual reproductive success of those colonies was also evaluated, using survey data collected by the Division of Fish and Wildlife since 1977. ChemRisk completed a series of statistical analyses to ascertain whether reproductive success varied with distance from the river (and presumably with rate of ingestion of Housatonic River fish).

- ChemRisk was retained by legal counsel on behalf of a synthetic rubber manufacturing company to provide technical oversight and review of an ecological risk assessment prepared by another consulting company for a waterway contaminated with PCBs. ChemRisk provided a detailed technical review of the ecological characterization, exposure analysis, and toxicological findings in the assessment. ChemRisk focused its technical review on factors such as the criteria used to select the chemicals of concern,

the selection process for indicator species, the characterization of feeding ranges for the species of concern, and the interpretation of the results. Although the original assessment projected unfavorable ecological impacts because its scope was limited to an evaluation of risks to benthic invertebrates based on comparisons to sediment quality criteria, ChemRisk advocated methods that characterize effects at the top of the food web in evaluating the ecological effects of contamination in this environment. ChemRisk's approach focused on the great blue heron, a sensitive species that had the potential to be exposed to the highest chemical concentrations attributable to the site. This "top-down" approach is an important risk verification technique that discriminates specific chemical effects from other non-chemical effects. In this case, an evaluation of a species at the top of the food web demonstrated that the site biota were not adversely affected by site-related chemicals. Based on ChemRisk's recommendations, the ecological risk assessment was substantially improved to accurately reflect the ecological integrity of the creek. The revised report was accepted by the Indiana Department of Environmental Management. ChemRisk was subsequently contracted by this firm to complete an ecological risk assessment for a second site; this work is ongoing.

Section 2.0 presents ChemRisk's understanding of the project. The technical approach proposed by ChemRisk for NUCOR Steel's Darlington, South Carolina facility is described in Section 3.0. Estimated costs associated with each of the proposed tasks are presented in Section 4.0, and a schedule for the conduct and completion of each of these tasks is presented in Section 5.0. The project team and experience summaries for key individuals are provided in Section 6.0. In addition, resumes for the project team are provided in Appendix A.

2.0 FACILITY DESCRIPTION AND PROJECT UNDERSTANDING

As noted in the facility information supplied in the RFP, NUCOR Steel is located approximately 5 miles north of Darlington, South Carolina on the eastern side of U.S. Highway 52. The Site encompasses approximately 500 to 600 acres. The property is bounded to the north by Black Creek and by Lucas Creek for a portion of the southwestern boundary. NUCOR Steel is a "minimill" steel manufacturing facility that currently consists of a melt shop with an electric arc furnace to melt scrap metal, a caster to form steel billets, and two roll mills which shape the steel into various products.

Lucas Creek follows the property boundary for approximately 2000 feet before it is joined by a stormwater discharge pipe leading from the plant. The Creek then flows for approximately 1500 feet before it enters an onsite surface water body called Nucor Pond. The pond covers approximately 10 acres and is surrounded by wood on most sides. Upon discharging from the pond, Lucas Creek flows for another 4000 feet before it joins with Black Creek. Lucas Creek has an estimated flow of 5 cubic feet per second (cfs). Black Creek empties into the Great Pee Dee River, which empties into the Waccamaw River and ultimately into the Atlantic Ocean.

Based on information supplied by NUCOR Steel, the South Carolina Department of Health and Environmental Control (DHEC) has not specifically classified Lucas Creek under South Carolina Classified Waters (R61-69). However, pursuant to R.61-69, unclassified surface water bodies are assigned the classification of the surface water body into which they are tributary, in this case Black Creek. Black Creek is classified as FW, which is specified by South Carolina Water Classifications and Standards (R.61-68) as "Freshwater suitable for primary and secondary contact recreation and as a source for drinking water after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural use."

According to the Site Investigation Report, completed for the DEHC in September 1993, wetlands are shown on the U.S. Geological Survey quadrangle topographic map along the entire northern property boundary of the Site. Along the southern edge, Lucas Creek is shown as having approximately 1500 feet of wetlands prior to entering Nucor Pond. Other extensive areas of wetlands are noted along the southern edge of the property.

Two sampling event have occurred in Lucas Creek. In January 1993, one surface water sample and one sediment sample were collected at each of three locations in Lucas Creek. The sampling locations included upstream of the facility, adjacent to the stormwater outfall from the facility, and downstream before the creek enters Nucor Pond. The Lucas Creek sampling was complimented by sampling in Black Creek, which included one surface water sample and one sediment sample collected at each of three locations.

The results of that sampling indicated that elevated concentrations of inorganic constituents were present in the sediment samples collected adjacent to the stormwater outfall and downstream from the stormwater outfall. The highest concentrations were detected at the downstream sample, with lead at 2180 mg/kg and zinc at 15,000 mg/kg. The inorganic concentrations in the sample adjacent to the stormwater outfall were also elevated with copper at 948 mg/kg, lead at 213 mg/kg, and zinc at 1460 mg/kg. Inorganic concentrations in the upgradient sample were below the levels of various guidelines used in the evaluation of sediment quality. The concentration distribution suggests that the metals were washed into Lucas Creek through the stormwater outfall and deposited downstream due to normal migration patterns in the creek.

Inorganic concentrations in the sediment samples from Black Creek were also below what is considered to be background. Elevated inorganic constituents were detected in the surface water samples collected adjacent to the stormwater outfall (lead at 12.5 ug/l and zinc at 236 ug/l), and the downstream location (lead at 7.85 ug/l and zinc at 203 ug/l).

A second round of surface water and sediment sampling was conducted in March 1993 by DHEC. Split samples were collected by NUCOR from that sampling event. Samples were from

locations in both Lucas Creek and Black Creek. Elevated concentrations of polychlorinated biphenyls (PCBs) were identified in the DHEC sediment samples from Lucas Creek. The inorganic constituents detected by DHEC and NUCOR in the sediment and surface water samples from Lucas Creek and Black Creek were comparable to the concentrations detected in the samples from the January 1993 sampling event.

As part of historic sampling that has occurred in Lucas Creek and Black Creek, fish were collected from the two water bodies during the February to May 1993 time frame. The fish were analyzed for inorganic constituents in the edible tissue (filets) portion of each fish. Lead was detected in Black Creek fish tissue at a maximum concentration of 2.96 mg/kg. Zinc was detected in Lucas Creek fish tissue at a maximum concentration of 32 mg/kg and in Black Creek fish tissue at a maximum concentration of 16.2 mg/kg. According to an evaluation of the residual concentrations conducted by General Engineering Laboratories on behalf of NUCOR, no potential health issues were attributed to these concentrations

The RFP has requested an environmental assessment of Lucas Creek, with findings and recommendations assimilated into a comprehensive report. Historic sampling that has been conducted in Lucas Creek has indicated that elevated concentrations of metals and some PCBs exist in the sediments. It has been suggested that the source of these constituents maybe the NUCOR Site. However, the data also suggests that the presence of these constituents is the result of historic activities as opposed to current plant practices. This preliminary assumption is primarily based on the low levels of inorganics in surface water samples, as compared to the sediment samples. Additionally, the low levels of inorganic residues in fish tissue that are present in this aquatic system suggest the possibility that the metals are not readily bioavailable. metals Are bioavailable, due to ppm measured concentrations in fish tissue.

With this philosophy, the proposed assessment outlined in Section 3.0, has been designed to fill in the data gaps regarding the impacts these constituents of concern may be having on the aquatic environment associated with Lucas Creek. Those data gaps are oriented around several key points, including: 1) potential receptors at risk; 2) bioavailability of the metals in the sediments; and 3) migration potential and associated pathways. The technical approach that is

proposed by ChemRisk is to utilize a compilation and detailed evaluation of the existing data, supplemented with the information needed to fill the aforementioned data gaps, to provide NUCOR with an understanding of the impact of the current conditions and recommendations for additional studies or activities. This proposed study will emphasize the evaluation of potential COCs in sediments.

3.0 TECHNICAL APPROACH

The objective of the proposed project is to conduct an environmental assessment of Lucas Creek and to evaluate the potential human health and ecological risks associated with the presence of constituents of concern (COCs). ChemRisk proposes to conduct this project using what has been termed a "top-down approach". This approach will allow for a "global" evaluation of the ecological health at the site, with respect to the surrounding environs and to determine if there have been population or community level impacts that can be specifically attributed to Site-related COCs. The "top-down" investigation that ia envisioned by ChemRisk at this early stage in the process would address the overall health of ecological communities that may be exposed to COCs in the wetland and aquatic habitats on and adjacent to the Site.

The overall management strategy suggested by ChemRisk would assemble all surface water and sediment data associated with Lucas Creek, the Nucor Pond and Black Creek. Coupled with a comprehensive Site characterization, that information would be utilized to:

presumptive—

- Show that Black Creek has not been impacted by site operations and that Black Creek represents "local background" conditions;
- Evaluate surface water and sediments between Black Creek and the Nucor Pond;
- Evaluate surface water and sediments in the Nucor Pond and in Lucas Creek from the initial point of contact with the Site to the Nucor Pond;
- Show that surface water has not been adversely impacted by NUCOR operations, and; presumptive
- Use sediment analysis data combined with environmental fate and transport (EF&T) information and bioavailability data to further "focus" the DHEC regarding realistic potential areas of concern (AOCs). ?

After the investigation has been focused on the realistic AOC(s), a risk assessment could be performed to confirm risks associated with COCs, health-based remedial objectives could be developed, or regulatory petitions seeking deferral of remediation based on no significant current

health risks could be developed. ChemRisk believes strongly that a comprehensive, well thought-out management strategy will be of significant economic and human resource benefit to NUCOR.

As described in the closing paragraph(s) of Section 3.1.1, additional data to support an evaluation of bioavailability, and a quantitative evaluation of environmental fate and transport may be beneficial to the overall analysis of ecological risk. Additionally, if remediation is required at the Site, this data can be used in a feasibility study to support ~~more favorable~~ Site-specific health-based cleanup objectives.

need current data (sw+sed). Most recent is 2½ yrs old

ChemRisk believes that a sufficient number of sediment and surface water samples have been collected to adequately characterize the quality of those matrices in Lucas Creek. However, the potential for the expression of a realistic level of environmental risk from those concentrations cannot be determined without additional data. Gibberish!

Using the "top-down" or ecosystem approach, ChemRisk proposes to identify potential receptors through an ecological characterization of the Site, evaluate the overall health of the aquatic habitat through a qualitative study of indigenous biota, and to assess the functional capabilities of sensitive ecosystems associated with Lucas Creek. Additionally, ChemRisk proposes to evaluate the relative availability of COCs in the environment, with the understanding that the simple presence of a COC does not pose a risk in the ecosystem if those materials are not bioavailable to receptors. Finally, ChemRisk proposes to evaluate the potential for movement of the COCs up the food chain and the possibility for impacts to higher trophic levels, including fish-eating birds and mammalian predators.

Again, the primary objective of these actions is to evaluate the potential risks associated with the presence of COCs in the sediments and surface waters of Lucas Creek. Once an understanding of those risks has been developed, then ChemRisk proposes to develop a set of recommendations to NUCOR regarding future courses of action. Those recommendations will take into consideration an evaluation of potential applicable regulatory mechanisms to be

completed as part of this project. Additionally, ChemRisk will include a remedial evaluation to ascertain potential engineering controls or actions that could be taken by NUCOR.

To effectively and efficiently conduct this project, ChemRisk proposes to complete the following tasks:

Task 1 - Risk Evaluation
Task 2 - Regulatory Assessment
Task 3 - Remedial Assessment
Task 4 - Recommendations and Report Preparation

These tasks are described in the following sections.

3.1 TASK 1 - RISK EVALUATION

The risk evaluation will be performed under the standard framework outlined in the U.S. Environmental Protection Agency's (EPA's) *Framework for Ecological Risk Assessment* (EPA/630/R-92/001), which includes problem formulation, analysis, and risk characterization. This framework was developed in accordance with regulatory guidance contained in *Risk Assessment Guidance For Superfund, Volume II, Environmental Evaluation Manual* (EPA/540/1-89/001). Other pertinent guidance documents which will be utilized in the development of the ecological assessment for the Site will include *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference* (EPA/600/3-89/013); *Developing a Work Scope for Ecological Assessments* (EPA 9345.0-05I); and, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (Review Draft, EPA Environmental Response Team, Edison, NJ).

This task is intended to evaluate whether impacts to receptors in Lucas Creek exist as a result of the presence of COCs in the sediments. Additionally, this task will provide an understanding

of the potential for future risks to environmental receptors. The following activities will be conducted as part of this task.

3.1.1 Site Characterization

lack of sufficient sampling + analyses to characterize potential sources of continuing releases, AND extent of contamination in Lucas Creek sediment.

As a first step in this integrated approach, ChemRisk will conduct a comprehensive characterization of the Site. The ultimate success of any phase of an ecological assessment will depend upon an accurate Site characterization, including an understanding of the available habitats, and potential exposure pathways for ecological receptors that exist at the Site. The objective of the Site characterization task is to thoroughly evaluate aspects of the Site that influence potential ecological exposures to COCs.

A two-day Site characterization will be performed by ChemRisk ecologists. The purpose of the reconnaissance is to characterize the wetland and aquatic habitats that are associated with Lucas Creek. A photographic survey will be performed as part of this effort to document ecological resources and aid in the delineation of habitat types. Readily available information on endemic populations of fish and other possible receptors will be obtained from the offices of local, state and federal agencies responsible for natural resource management. Potential migration pathways, including stormwater runoff, will be evaluated. Possible evidence of stressed vegetation or fish kills will be evaluated. Information will be collected on the potential functions and values of the wetlands systems associated with Lucas Creek. The rationale for performing this evaluation is that a wetland unit that is impaired by a stressor of some type should not be able to perform the functions of a non-stressed wetland.

While ChemRisk believes that sufficient information exists to characterize the quality of sediments in Lucas Creek, information on the bioavailability of COCs in the sediments is not present. If COCs in sediments are not available to ecological receptors for uptake, then the risks afforded by their presence is limited. In many situations, inorganic constituents can tend to bind to non-hazardous materials in sediments such as clay particles or organic materials, thereby limiting their availability for uptake. To evaluate the issue of bioavailability, ChemRisk

no SW sampling to confirm that WQS aren't being exceeded in Lucas Creek.

no fish sample specified.

proposes to take samples from four locations within Lucas Creek. The samples will be analyzed for grain size distribution, total organic carbon (TOC), and acid volatile sulfide/simultaneously extractable metals (AVS/SEM). The AVS/SEM analysis is considered to be a direct measure of the potential bioavailability of divalent metals (such as copper) that are present in sediments, based on the concentrations of sulfides in sediment which preferentially bind such metals. The TOC analysis is a measure of the quantity of organic material present which could potentially bind metals and PCBs. Grain size will determine the percentage of small particle size sediments that metals would tend to adhere to. This investigation will focus on surface sediments in the biologically active zone (i.e., upper six inches of sediments).

3.1.2 Problem Formulation

The environmental assessment that ChemRisk proposes be performed at the Site is a focused, goal-oriented study, based on the current framework for the completion of ecological risk assessments (*Framework for Ecological Risk Assessment,* EPA/630/R-92/001). A review of the existing Site investigation data, in conjunction with the Site Characterization (Section 3.1.1) will support the first step of the framework, which is problem formulation. Problem formulation includes a preliminary characterization of the potential exposure and effects, as well as the examination of data needs, policy and regulatory issues and Site-specific factors necessary to define the feasibility, scope, and objectives for the ecological assessment. The result of the problem formulation is a conceptual Site model (CSM), which includes a preliminary Site characterization, a description of the possible stressors to the ecosystem (chemical and physical), a discussion regarding the assessment endpoints for the stressors (i.e., toxicity, bioaccumulation, etc.), and a conceptual approach for evaluating the possible effects of stressors on the ecosystem. Completion of this step is critical to the development of a scientifically defensible ecological assessment. Poorly defined objectives can lead to an excessively conservative assessment of potential ecological impacts.

3.1.3 Exposure and Effects Analysis

The second step in the ecological risk assessment is the analysis phase. Analysis consists of exposure assessment, and the characterization of ecological effects. The analysis step of the environmental assessment will include a realistic evaluation of potential exposure pathways, and exposure scenarios pertinent to the ecological receptors identified at the Site. The exposure assessment will be based on information obtained during the Site characterization, local and regional ecological data, and scientific principles of population ecology.

The analysis will be supported by a thorough and meaningful compilation and review of the existing data. These data are required to develop a comprehensive understanding of the risks posed by COCs in the sediments. ChemRisk will review information on the physical characteristics of the Site environs, including hydrography, surrounding land use, presence and extent of aquatic and wetland habitats, and ecological community data. As part of this phase an evaluation of fate and transport mechanisms associated with the sediments in Lucas Creek will be conducted.

For the ecological effects assessment, a thorough evaluation of the toxicology of COCs which were detected in sediments in historic Site investigations, to aquatic organisms will be performed. Available and relevant information will be summarized in ecotoxicological profiles for each COC. This information will be used to evaluate the potential for ecological effects, based on the exposure potential and the concentrations of COC that may adversely effect ecological receptors at the Site.

3.1.5 Risk Characterization

The third step of the environmental assessment is a qualitative risk characterization. The risk characterization will evaluate the likelihood of ecological impacts, based on the problem formulation, the realistic exposure analysis and characterization of ecological effects completed

in the analysis phase. The risk characterization step will include a qualitative discussion on the potential for adverse ecological effects from COCs at the Site.

based on predicted not measured values

The risk characterization will consist of the comparison of exposure concentrations in the surface water and sediment samples to "safe values" or threshold criteria identified in the available scientific literature. For surface water, threshold criteria will include Ambient Water Quality Criteria (AWQC). AWQCs are developed based upon the use of LD_{50} (a statistically or graphically estimated dose that is expected to be lethal to 50% of a group of organisms under specified conditions) results associated with standard acute and chronic bioassay testing modified by safety factors. not proposed for this study

Concentrations of COCs in sediments will be compared to U.S. Environmental Protection Agency Region IV sediment screening values. Sediment guidelines for comparison will also include the Effects Range-Low (ER-L) values published by Long and Morgan in The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program (NOAA Technical Memorandum NOS OMA 52, 1991). ER-L values are concentrations in sediment at the low end (10th percentile) of the range in which effects were observed or predicted. They are used by NOAA as concentrations above which adverse effects may begin or are predicted among sensitive life stages and/or species as determined in sublethal tests. "Effects" do not necessarily imply mortality in this case. These values are used by NOAA to rank sites with regard to the potential for biological effects. not really!

If Region IV or NOAA values are not available for a particular analyte, then the data will be compared to the Ontario Sediment Guidelines (Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, Ontario Ministry of the Environment, 1993), or the Apparent Effects Threshold (AET) values developed by Tetra Tech (1988).

Other regulatory criteria which may be identified during the literature review and considered appropriate for both media will also be utilized. Where no regulatory criteria are available for a COC, threshold values identified in the available scientific literature will be utilized for

comparison purposes. Threshold values will consist of No Observed Effect Levels (NOELs) or No Observed Adverse Effect Levels (NOAEL) for aquatic fish (for surface water) and invertebrates or benthic macroinvertebrates (for sediments). Dose-response information for a single identified species in the literature may be used as a threshold value for the health of the entire surface water or sediment community, as appropriate. If NOAELs or NOELs are not available for a particular COC, then LD_{50} and Lowest Observed Effect Level (LOEL) data, with appropriate uncertainty factors, will be utilized.

The characterization of the level of potential risk to aquatic resources will be expressed as a hazard quotient (HQ). The HQ is a ratio of the exposure value identified in the surface water and sediment samples for individual COCs to the benchmark threshold criteria. The HQ is expressed using the following equation:

$$\text{Hazard Quotient (HQ)} = \frac{\text{Exposure Concentration of COC}}{\text{Threshold/Regulatory Criteria}}$$

A Hazard Index (HI), representing the sum of the HQs for each COC will then be calculated for each surface water and sediment sample.

HQs are only appropriate for chems with consistent modes of toxicity

The HQs and HIs will be interpreted using the following EPA-approved approach:

- If the HI or HQ is less than or equal to 1, then there is a low probability of adverse ecological impacts to aquatic receptors as a result of exposure to the COIs;

- If the HI or HQ ranges between 1.0 and 10.0, then there is a possibility of adverse ecological impacts to aquatic receptors as a result of exposure to the COIs; and

- If the HI or HQ is greater than 10.0, then it is probable that adverse ecological impacts would occur to aquatic receptors as a result of exposure to the COIs.

To conclude the risk characterization, a simple food chain assessment will be conducted for a select number of bioaccumulative inorganics and on the PCBs. This exercise will evaluate the potential for ecological impacts to higher order trophic levels such as fish-eating birds or mammals.

3.2 TASK 2 - REGULATORY ASSESSMENT

As an integral part of the project, ChemRisk will review and identify the appropriate and applicable regulatory features pertinent to NUCOR and Lucas Creek. ChemRisk will utilize on-line computer databases and summary journals to identify present and future South Carolina and federal regulations or guidances that may have jurisdiction over the Site. Knowledge and understanding of these vehicles will help NUCOR fulfill regulatory requirements. The results of this evaluation will be included in the final report.

3.3 TASK 3 - REMEDIAL ASSESSMENT

As a final part of the evaluation of Lucas Creek, ChemRisk proposes to take the data developed in Task 1 and the information identified in Task 2, and evaluate it with regards to possible engineering controls and actions necessary to address possible concerns. While Task 1 may identify future studies that would be necessary to complete the evaluation of Lucas Creek, it is to the benefit of future decision making processes that a preliminary evaluation of the engineering options be conducted. To that end, a engineer familiar with remediation activities will examine the available information and will develop a list of potential actions, with an estimated range of possible costs. The results of this information will be included in the final report.

3.4 TASK 4 - RECOMMENDATIONS AND REPORT PREPARATION

The conclusions and data developed during the completion of these tasks will be presented in a detailed Environmental Assessment report for the Site. The data evaluation presented within

that document will serve to characterize the potential for ecological risks associated with COC at the Site. Both spatial and temporal considerations of ecological risk will be presented. Discussion of how the Site-specific data relates to the scientific literature will be provided. An uncertainty analysis will be included in the report and will present a qualitative discussion of the uncertainties inherent to the assessment. A description of the regulatory processes pertinent to the Site will be presented, as well as the preliminary evaluation of possible engineering controls. Recommendations for future studies or actions will be detailed. As part of the report, a Site map detailing potential areas of concern will be prepared. As requested, the map will be prepared in .DXF format.